Sturgeon CPUE from Commercial Passenger Fishing Vessels and White Sturgeon CPUE from a Mark-Recapture Study

Jason DuBois and Marty Gingras

jason.dubois@wildlife.ca.gov

Introduction

The California Department of Fish and Wildlife (CDFW) has conducted a mark-recapture study of San Francisco Estuary sturgeon at intervals since 1954 (Pycha 1956) and White Sturgeon abundance is one of many metrics developed from the data. Because the abundance estimates are infeasible to produce quickly and are sometimes quite imprecise, development of an abundance index (e.g., catch per unit effort (CPUE)) would be helpful. With an eye toward caveats to the data, we have recently explored a range of ways to calculate sturgeon CPUE from Commercial Passenger Fishing Vessel (CPFV) data and White Sturgeon CPUE from catch during tagging for the CDFW mark-recapture study. Here we present a brief summary of comparisons between and among those metrics.

White Sturgeon CPUE from tagging for the mark-recapture study is straightforward to calculate and we routinely report it. However — because the mark-recapture study has only deployed trammel nets in San Pablo Bay and/or Suisun Bay during August, September and October — CPUE from tagging might not reflect system-wide trends in annual abundance. Interpretation of the White Sturgeon CPUE time series is complicated somewhat because prior to 1990 the nets were composed only of 8" stretched-mesh panels and were composed of 6", 7", and 8" stretched-mesh panels thereafter.

Operators of Commercial Passenger Fishing Vessels (CPFVs) are paid by anglers to target and catch a fish species of interest (e.g., White Sturgeon), and CPFV operators are required to complete and submit to the CDFW a log for each trip. It is possible to calculate CPUE from log data, because each log contains information on catch by species (or species aggregations), number of anglers, time fished, and date fished, as well as the location (called 'blocks') where most fish were caught (Hill and Schneider 1999). Interpretation of a sturgeon CPFV CPUE time series is somewhat confounded because logs contain no length data and because size limits on White Sturgeon since 1980 changed from ≥102, 107-183, 112-183, 117-183, and 117-168 (centimeters Total Length; DuBois et al. 2012). Furthermore, CPFV sturgeon catch as of 2012 had not been identified to species in logs and CPUE calculated from data prior to March 2007 — when it became illegal to take Green Sturgeon — no doubt includes catch of White Sturgeon *and* a relatively few Green Sturgeon whereas thereafter likely includes nearly no Green Sturgeon.

Investigation

We only used CPFV data from 1980-2012, because log data prior to 1980 is now only available as monthly summaries (Hill and Schneider 1999) and thus it is impossible to calculate species-specific effort from that portion of the dataset. We calculated annual CPUE (per Equation 1, where t = year) by using criteria based on catch (at least 1 sturgeon noted; kept fish; kept fish plus released fish) and fishing location (i.e., 'blocks' Table 1), as well as on whether or not CPFVs targeted sturgeon and on sturgeon fate (i.e., harvested or released; Table 1). Some of these CPUE 'permutations' use nearly the same data.

$$CPUE_t = \left[\frac{\sum catch_t}{\sum anglerhours_t} \right] \times 100 \qquad\qquad \text{Equation 1}$$

When comparing 12 CPFV CPUE permutations by way of scatter plots (Figure 1 for examples; upper-most 7 rows), we found that the relations often vary substantially. Just 11 of 66 comparisons had R-squared >0.50 (range 0.52-0.99; avg 0.73) and several of those are notably attributable to an outlier (Suisun Bay in 1998).

We calculated annual White Sturgeon CPUE from tagging per Equation 1, except effort was in terms of net-fathom-hours rather than angler-hours. When comparing 12 CPFV CPUE permutations to 2 permutations of tagging CPUE (Figure 1 for examples; lower-most 2 rows), we found that just two of 24 comparisons had R-squared >0.50 (range 0.58-0.70; avg 0.64). Tagging CPUE was most similar to CPFV CPUE when considering fish legal-sized during tagging relative to trips targeting sturgeon in Suisun Bay and system-wide, but was only slightly less similar when considering all trips. Use of fish fate (e.g., kept fish plus released fish) did not usually improve the relation between CPFV CPUE and tagging CPUE.

Annual effort for each CPFV CPUE permutation varied from zero (just 4 instances) to 26108 hours (avg 7728 hours), which suggests that relatively few of the CPFV CPUE values are substantially influenced by outliers. The time series of annual effort by CPFV CPUE permutation (Figure 2) reflects the general trends in CPUE, which suggests that the CPFV fishery responds strongly to variations in CPUE.

Figure 3 shows typical trends in CPFV CPUE for sturgeon, including (a) variations that correspond to the recruitment and subsequent decline of strong year-classes that must have been produced during 1969-1975 when most years were classified as wet (see Kohlhorst 1980 for evidence regarding 1969 and 1970) and (b) strong year classes produced in and augmented by hatchery production in some wet years during the early 1980s (Kohlhorst et al. 1991; Fish 2010; Monaco 1983; Steinhart 1986). Figure 3 also shows trends in White Sturgeon CPUE from tagging and — though sparse due to less-than-annual tagging — recruitment and subsequent decline of strong year-classes is evident.

Discussion

CPFV CPUE for sturgeon varies substantially by location and angler motivation and does not vary monotonically with CPUE for White Sturgeon from tagging. However, a similar trend is tracked by some permutations of tagging CPUE, system-wide CPFV CPUE, and Suisun Bay CPFV CPUE — and from that we consider those as complementary 'caveated indices' of system-wide White Sturgeon abundance.

As of now, the best relations between tagging and CPFV CPUE come from data (i.e., species targeted; released fish) that has been required of CPFVs only since 1995. For that reason and because in 2011 (and again in 2013) the CDFW instructed CPFV operators to identify sturgeon to species, we expect stronger relations between tagging and CPFV CPUE in the future.

After looking at the White Sturgeon length frequency distributions by mesh size, we attribute the extremely large CPUE values from the mark-recapture study in 1984 and 1985 to unusual distributions of fish rather than rapid changes in the system-wide abundance of fish or bias attributable to mesh size. In hopes of learning more about White Sturgeon migrations and ecology (e.g., responses to Delta outflow), we plan to look into those 1984 and 1985 tagging CPUE outliers as well as the CPFV CPUE outlier from 1998 (Suisun Bay).

References

DuBois, J., M. Gingras and G. Aasen. 2012. Status and Trends of San Francisco Estuary White Sturgeon. Interagency Ecological Program for the San Francisco Estuary Newsletter 24(1): 50-55.

Fish MA. 2010. A white sturgeon year-class index for the San Francisco Estuary and its relation to delta outflow. Interagency Ecological Program for the San Francisco Estuary Newsletter 23(2): 80-84.

Hill KT, Schneider N. 1999. Historical Logbook Databases from California's Commercial Passenger Fishing Vessel (Partyboat) Fishery, 1936-1997. Scripps Institution of Oceanography, Ref. Series No. 99-19, 65 p.

Kohlhorst, DW. 1980. Recent trends in the white sturgeon population in California's Sacramento-San Joaquin Estuary. California Fish and Game 66(4): 210-219 (1980).

Kohlhorst, DW., LW. Botsford, JS. Brennan, and GM. Cailliet. 1991. Aspects of the structure and dynamics of an exploited central California population of white sturgeon (Acipenser transmontanus). In P. Williot (ed.). Acipenser. Proceedings of the First International Symposium on the Sturgeon. Bordeaux: CEMAGREF. pages 227-293.

Monaco, G. 1983. A general description of sturgeon aquaculture currently being conducted at the University of California at Davis. Cal-Neva Wildlife Transactions.

Pycha, RL. 1956. Progress report on white sturgeon studies. California Fish and Game 42:23-35.

Steinhart, P. 1986. The caviar connection. National Wildlife. December/January.

Figure 1 Scatter plot matrix comparing various CPFV CPUE for sturgeon and CPUE for White Sturgeon caught during tagging (Table 1); upper panels with loess line, lower panels value = R^2 (values in red > 0.5)

Figure 2 Time series (1980-2012) of effort (as angler-hours) from CPFVs for various permutations (Table 1)

Figure 3 Time series (1980-2012) of tagging CPUE (tag.legal.stu; as catch per 100 net-fathom-hours; top figure) and of CPFV CPUE (as catch per 100 angler-hours; bottom figure) for select permutations (Table 1)

Table 1 Description of criteria used for CPUE permutations

CPUE Permutation	Criteria Used for Calculating CPUE
suc.stu.sfe	successful trips only; kept only; no target; all blocks east of Golden Gate Bridge
all.stu.sfe	all trips; kept only; no target; all blocks east of Golden Gate Bridge
all.targ.stu.sfe	all trips; kept only; target sturgeon; all blocks east of Golden Gate Bridge
all.kept.rel.sfe	all trips; kept + released; no target; all blocks east of Golden Gate Bridge
suc.stu.spb	successful trips only; kept only; no target; only block 301 (San Pablo Bay)
all.stu.spb	all trips; kept only; no target; only block 301 (San Pablo Bay)
all.targ.stu.spb	all trips; kept only; target sturgeon; only block 301 (San Pablo Bay)
all.kept.rel.spb	all trips; kept + released; no target; only block 301 (San Pablo Bay)
suc.stu.sb	successful trips only; kept only; no target; only blocks 302 and 308 (Suisun Bay)
all.stu.sb	all trips; kept only; no target; only blocks 302 and 308 (Suisun Bay)
all.targ.stu.sb	all trips; kept only; target sturgeon; only blocks 302 and 308 (Suisun Bay)
all.kept.rel.sb	all trips; kept + released; no target; only blocks 302 and 308 (Suisun Bay)
tag.all.stu	white sturgeon caught during tagging, regardless of size (length)
tag.legal.stu	white sturgeon caught during tagging legal-sized at time of capture

successful trips includes trips where catch (as kept only) ≥ 1

all trips includes trips where catch (as kept or as kept + released) ≥ 0

kept only means catch includes only number of kept sturgeon

kept + released means catch includes number of kept + released sturgeon

no target means vessel did not specifically target sturgeon